More patients are treated for nonruptured abdominal aortic aneurysms, but the proportion of women remains unchanged

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Background: **Large variations in the intervention rates for ruptured and nonruptured abdominal aortic aneurysm (AAA) over time have been reported, both decreasing and increasing numbers. Women have been reported to constitute an increasing proportion of patients treated for several manifestations of cardiovascular disease; whether a similar trend is true for AAA is not well understood. This study investigated recent temporal trends in a complete national register regarding the number and type of procedure performed for AAA, and outcome, with special emphasis on gender differences.**

Methods: **Data for all individuals treated for nonruptured or ruptured AAA in Sweden (1990 to 2005) were obtained from the Swedish National Board of Health and Welfare (NBHW). A total of 14369 individuals were identified; 2327 (16%) were women. Date and type of intervention, date and cause of death, age, and sex were included in the statistical model.**

Results: **There was a relative annual increase in interventions for nonruptured AAA; 4% for women ($P < .0001$) and 2% for men ($P < .0001$). No significant trends were observed for interventions for rupture during the observation period. No significant increase in the proportion of women was recorded for nonrupture (17%) or rupture (15%). Women had higher crude 30-day mortality rate than men after treatment for both nonruptured (5.7% vs 4.9%) and ruptured (41.9% vs 36.8%) AAA. In a logistic regression model, survival improved over time after intervention for nonrupture ($P < .0001$) and rupture ($P < .0001$). Increasing age ($P < .0001$ for both nonrupture and rupture) but not sex ($P = .49$ for non rupture and $P = .42$ for rupture) had a negative influence on mortality.**

Conclusion: **Interventions for nonruptured but not for ruptured AAA increased over time, with an expected rapid increase of endovascular repair in the nonruptured group. The unchanged fraction of women over time possibly reflects the true distribution of AAA between the sexes. The outcome after treatment for both nonruptured and ruptured AAA improved, as anticipated, over time. No increase in mortality among women was recorded after adjustment for age. (J Vasc Surg 2008;48:802-7.)**

The prevalence of abdominal aortic aneurysm (AAA) has been reported to increase.[1-4] Atherosclerotic disease is a risk factor for AAA. Consequently, it is possible that the number of women treated for AAA will increase, similar to an observed growing number of women treated for various other manifestations of atherosclerosis.[5,6]

Several important gender differences for AAA have been described: women have a lower prevalence rate,[7,8] a higher mean age at onset of disease and time for treatment,[9,10] and possibly poorer outcome.[11-13] Women are also reported to have a higher risk of rupture at a given diameter and a higher aneurysm growth rate than men.[14-17] Relative AAA diameter based on the predicted size in relation to body surface area is larger in women than men.[18]

Large variations in the intervention rates for ruptured and nonruptured AAA over time—both decreasing and increasing numbers—have been reported.[10,9-22] The aim of this study was to investigate recent temporal trends in a complete national register for number and types of procedures performed for AAA and outcome,with special emphasis on gender differences. The study identified individuals treated for AAA in Sweden during a 16-year period by linking nationwide databases managed by the Swedish National Board of Health and Welfare (NBHW).

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METHODS

National registries. All Swedish citizens have a unique 12-digit personal identification number that facilitates identification on a patient-specific level in national registries. The Swedish National Hospital Discharge Register, managed by the NBHW, covers all information regarding public inpatient care. The Cause-of-Death Register is managed by The Centre for Epidemiology (EpC) at NBHW and covers data for causes of death for all deceased individuals in hospitals and at home. Statistics Sweden (SCB) is responsible for official statistics for the population, divided by age and sex. The extraction of data was based on the procedural codes for AAA, according to the *Classifica-*

Table I. Logistic regression analysis of 30-day mortality for patients treated for nonruptured abdominal aortic aneurysm

All-cause mortality	*Point estimates*	*95% CL*	P
Sex			
Men	1.00	Ref	.49
Women	1.09	0.86, 1.38	
Age			
<60	1.00	Ref	<.0001
60-69	2.48	1.33, 4.65	
70-79	3.94	2.15, 7.25	
≥80	7.07	3.74, 13.37	
Calendar year			
1990-1993	1.00	Ref	<.0001
1994-1997	0.84	0.67, 1.05	
1998-2001	0.61	0.44, 0.84	
2002-2005	0.52	0.39, 0.68	
Procedure			
Open	1.00	Ref	.0032
EVAR	0.53	0.35, 0.81	

CL, Confidence limits; *EVAR,* endovascular aneurysm repair.

Table II. Logistic regression analysis of 31-day to 1-year mortality for patients treated for nonruptured abdominal aortic aneurysm

All-cause mortality	*Point estimates*	*95% CL*	P
Sex			
Men	1.00	Ref	.9965
Women	1.00	0.79, 1.27	
Age			
<60	1.00	Ref	<.0001
60-69	1.52	0.93, 2.49	
70-79	2.47	1.54, 3.96	
≥80	3.57	2.14, 5.95	
Calendar year			
1990-1993	1.00	Ref	.12
1994-1997	0.88	0.70, 1.11	
1998-2001	0.75	0.55, 1.02	
2002-2005	0.75	0.58, 0.97	
Procedure			
Open	1.00	Ref	.08
EVAR	1.29	0.97, 1.71	

CL, Confidence limits; *EVAR,* endovascular aneurysm repair.

tion of Surgical Procedures by the NBHW (edition 5, 6, and 7) and the diagnostic codes for AAA classified by clinical modifications 9 and 10 of the *International Classification of Disease* (ICD). The official code for classification of endovascular aneurysm repair (EVAR) was introduced 1997.

Study population. The number of persons treated, age at treatment, sex, and procedural codes were analyzed on a patient-specific level. The study cohort includes the 14,369 patients who were treated with open or endovascular repair for nonruptured or ruptured AAA from 1990 to 2005 in Sweden. The Swedish population was 8.6 million (50.4% women) in 1990 and 9.0 million (50.6% women) in 2005. This study was approved by the Regional Ethics Committee.

Table III. Logistic regression analysis of 30-day mortality for patients treated for ruptured abdominal aortic aneurysm

All-cause mortality	*Point estimates*	*95% CL*	P
Sex			
Men	1.00	Ref	.42
Women	1.07	0.91, 1.26	
Age			
<60	1.00	Ref	<.0001
60-69	1.80	1.28, 2.52	
70-79	3.37	2.43, 4.67	
≥80	5.70	4.05, 8.00	
Calendar year			
1990-1993	1.00	Ref	<.0001
1994-1997	0.81	0.70, 0.95	
1998-2001	0.71	0.59, 0.87	
2002-2005	0.60	0.51, 0.70	

CL, Confidence limits.

Table IV. Logistic regression analysis of 31-day to 1-year mortality for patients treated for ruptured abdominal aortic aneurysm

All-cause mortality	*Point estimates*	*95% CL*	P
Gender			
Men	1.00	Ref	.34
Women	1.16	0.86, 1.58	
Age			
<60	1.00	Ref	<.0001
60-69	0.97	0.57, 1.65	
70-79	1.53	0.93, 2.51	
≥80	2.38	1.40, 4.04	
Calendar year			
1990-1993	1.00	Ref	0.01
1994-1997	1.19	0.89, 1.58	
1998-2001	0.89	0.61, 1.30	
2002-2005	0.73	0.53, 1.00	

CL, Confidence limits.

Statistical analysis. Trends of surgical interventions were analyzed by Poisson regression, where population figures specific for age, sex, and calendar year were used as the denominator (ie, as an offset). Trends in age at surgery were analyzed by linear regression. The trends for intervention rates were analyzed in a Poisson regression model, with calendar time as a continuous variable and adjusted for age at time of surgery according to age- and sex-specific population numbers. Mortality rates were analyzed with a logistic regression model considering sex, rupture vs nonrupture, 10-year age groups, and calendar year (as presented in Tables I, II, III, and IV). Results are presented as odds ratios (OR) together with 95% confidence intervals. Crude comparisons of proportions were performed by χ^2 tests. Significance was defined as $P < .05$.

RESULTS

During the observation period more patients (65.4%) were treated for nonruptured compared to ruptured AAA. The majority of patients (83.8%) were male (Table V).

Table V. All patients treated for abdominal aortic aneurysm during 1990-2005 in Sweden

Aneurysm type	*Men, No (%)*	*Women, No (%)*	*Men + women*
Nonruptured			
Open	6901 (82.8)	1437 (17.2)	8338
EVAR	910 (85.6)	153 (14.4)	1063
All nonruptured	7811 (83.1)	1590 (16.9)	9401
Ruptured			
Open	4119 (85.1)	720 (14.9)	4839
EVAR	112 (86.8)	17 (13.2)	129
All ruptured	4231 (85.2)	737 (14.8)	4968
Nonruptured + ruptured	12042 (83.8)	2327 (16.2)	14369

EVAR, Endovascular aneurysm repair.

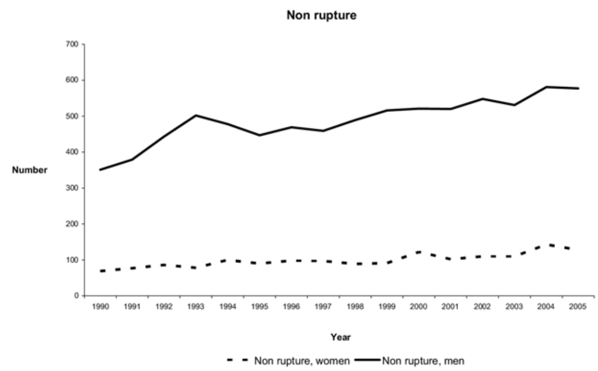

Fig 1. All men *(solid line)* and women *(dashed line)* treated for nonruptured abdominal aortic aneurysm in Sweden from 1990 to 2005.

Nonruptured AAA. Between 1990 and 2005, 9401 patients (16.9% women) were treated for nonruptured AAA (Fig 1). This represents an overall intervention rate of 30.6 per 100,000 inhabitants for nonruptured AAA in persons aged >60 years in 2002 to 2005. No significant increase was noted in the proportion of women during the observation period, 16.4% in 1990 and 18.2% in 2005 ($P =$ .17). In the Poisson regression model, a 4% relative annual increase in the intervention rate for surgery was recorded for women ($P <$ .0001) and 2% for men ($P <$ .0001). Overall, 11.3% of all patients were treated with EVAR during the study period. The proportion of EVAR increased from 1.7% in 1997 to 34.5% in 2005 for men and 1.0% to 25.0% for women. Mean age at intervention was 70.8 (SD, 7.4) years for men and 72.3 (SD, 7.5) for women. During the observation period, the age for women increased by 0.1 years ($P =$ .014) and for men by 0.2 years ($P <$ .0001) per calendar year.

Women had higher crude mortality than men (Table VI). This sex difference disappeared after adjustment for age, EVAR, and calendar year (Table I). Increasing age at time for treatment, open repair, and treatment during the first calendar years of the observation period were influential risk factors for 30-day mortality (Table I). Increasing age also had a negative influence on 31-day to 1-year mortality, but no influence of calendar year or open repair was recorded (Table II). The most common cause of death at 30 days was cardiovascular disease (women, 88%; men, 90%; $P =$ .57). Similarly, no sex differences in cause of death were seen for deaths that occurred ≤1 year.

Ruptured AAA. Of the 4968 interventions identified for ruptured AAA, 14.8% patients were women. The proportion of women increased slightly during the study period, from 15.8% to 18.5% ($P =$ .06). A mean of 15.0 interventions per 100,000 inhabitants aged >60 years occurred between 2002 and 2005. No significant annual relative increase was seen in the number of interventions for ruptured AAA during the observation period. In the Poisson regression model, a 1% relative annual increase in the incidence for surgery was recorded for women ($P =$ .09) and 0.5% for men ($P =$ .24; Fig 2). A greater proportion of all men were treated for ruptured compared with nonruptured AAA than women (35.1% vs 31.7%, $P =$ .001). No patients were treated with EVAR in 1997; this increased to 13% of men and 9% of women in 2005. Mean age was 72.4 (SD 7.8) years for men and 75.3 (SD 7.4) for women. The mean age increased for men by 0.2 years ($P <$ .0001) per calendar year, whereas mean age was unchanged for women.

The postoperative mortality rate ≤30 days was 37.6% (Table VI). Patients treated for rupture continue to have a high crude mortality rate ≤6 months (Table VI). Women treated for ruptured AAA had a higher crude 30-day mortality compared with men (41.9% vs 36.8%), this sex difference disappeared after age adjustment (Tables III and VI). Increasing age and treatment during the first calendar years of the observation period had a negative influence on 30-day mortality (Table III). Increasing age and treatment in the earlier calendar years also had a negative influence on mortality between 31 days and 1 year, but not gender (Table IV). Causes of death ≤30 days were similar for patients treated for ruptured AAA and patients treated for nonruptured AAA. The most common cause of death was cardiovascular disease, with no detectable sex difference.

DISCUSSION

The number of persons treated for nonruptured AAA during the last decades in Sweden increased, but the number of persons treated for ruptured AAA did not. The male/female ratio in treated patients also remained unchanged.

The increasing number of procedures performed for nonruptured AAA can be due to several factors. It could reflect an increase in the prevalence of AAA.[2,4] Several other factors probably contribute; including a higher detection rate, due to an increasing number of radiologic investigations, as well as an improved awareness of the disease. The increase could also indicate a more generous attitude towards treating elderly patients, confirmed by the increasing mean age in treated patients, as shown by others.[10,23]

Table VI. All deceased patients treated for nonruptured and ruptured abdominal aortic aneurysm

Aneurysm type	*No*	*0-30 days, No. (%)*	*31-180 days, No. (%)*	*181-365 days, No. (%)*
Nonruptured				
Men	7811	385 (4.9)	248 (3.2)	173 (2.2)
Women	1590	91 (5.7)	48 (3.0)	41 (2.6)
Ruptured				
Men	4231	1559 (36.8)	207 (4.9)	87 (2.1)
Women	737	309 (41.9)	47 (6.4)	13 (1.8)

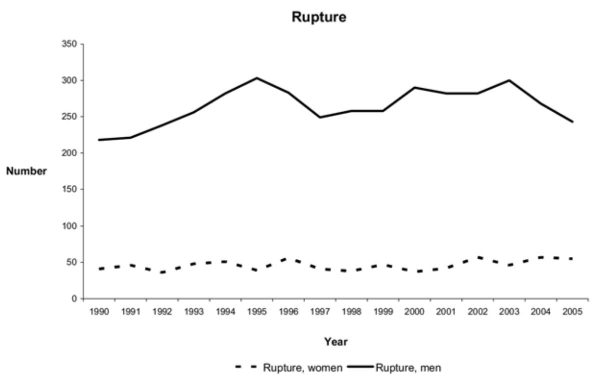

Fig 2. All men *(solid line)* and women *(dashed line)* treated for ruptured abdominal aortic aneurysm in Sweden from 1990 to 2005.

It is also obvious that Sweden still has a low intervention rate compared with the intervention rate in the United States that is almost three times higher (87.7/100000 inhabitants in 2003).[10] This cannot solely be explained by different prevalence rates of AAA, but rather emphasizes the need in Sweden to introduce screening programs. A high rate of interventions for AAA in Sweden is for ruptured rather than nonruptured AAA (34.6%). This should be compared with other countries, for example, the Netherlands (22% in 1992) and the United States (17% in 2001 to 2004); however, a higher rate of 30% was found in Finland (1991 to 1994).[20,22,24] The unchanged intervention rate for ruptured AAA in our report can probably partly be explained by the low intervention rate for nonruptured AAA in Sweden, as was mentioned.

It is difficult to find any recent comparative studies on temporal trends for ruptured and nonruptured AAA with a complete population-based approach. The reported temporal trends represent samples of the population, for example, persons aged >65 years or a region, and do not analyze nonruptured and ruptured AAA simultaneously. It is probable that large variations in the reported numbers of interventions more reflect possible screening programs, number of active vascular surgeons, study period, insurance policies, possibility to perform EVAR, and number of computed tomography scans in the region, rather than a specific prevalence rate of AAA in the population studied.[10,19-22,25] Our data could indicate an increased restrictiveness in the willingness to treat patients with rupture. Those admitted, but not treated, are not included in our register-based study. The low autopsy rate, 14% in 2005,[26] makes any further conclusions regarding the true number of ruptures impossible.

An overall unchanged female proportion of 16% among treated nonruptured patients could reflect the true distribution between the sexes.[7,8,27] Large variations in the proportion of treated women with nonruptured AAA can be found, however: 12% in Canada, 20% in the United States, and 23% in New Zealand.[20,23,25] The proportion of women treated for other manifestations of atherosclerotic cardiovascular disease has grown during the last decades, probably due to an increasing prevalence and a higher detection rate.[5,6] An increasing proportion of women with AAA in the future could therefore be expected; of course, we also expect an increase in the overall rate of interventions.

The ratio for rupture/nonrupture interventions was significantly different for women and men: Fewer women were treated for ruptured AAA. This could be due to a higher detection rate of intact aneurysms in women, but that seems unlikely. Authors have reported that women are less likely than men to be offered surgical intervention for ruptured AAA, even after consideration of age and comorbidities.[9,11,20,28] Again, the limitation of our study is that no conclusions can be drawn about the number of patients who were admitted but did not undergo surgery.

The 30-day mortality rate improved significantly for patients treated for nonruptured AAA during the observation period. A referral system for major vascular surgery has developed in Sweden during the last decades, implying that larger volumes of major vascular procedures are being performed in fewer centers. The influence of higher volume (hospital or surgeon) on improved outcome has been reported for AAA.[29-31]

Mortality rates for patients treated for nonruptured AAA occurring >30 days did not improve during the observation period, however. It is important to notice that this patient group has a continuously increased risk of death, even after the first immediate postoperative period, most prominently ≤6 months. In a previous report from our group, the standardized mortality ratio for patients surviving 60 days was 1.7 (range, 1.66-1.76), with a median survival of 8 years.[32]

Gender differences for outcome after nonruptured AAA repair vary. In agreement with our findings, these were equalized after age adjustment in a report from Canada.[33] In two recent reports, one based on the United States Nationwide Inpatient Sample (NIS), and a Swedish report based on the Swedish Vascular (SWEDVASC) registry, women had a higher in-hospital mortality rate, even after adjustment for age and comorbidities.[20,34] In the SWEDVASC report, the influence by increasing age, open repair, and early calendar years on 30-day mortality were similar to our results. Gender was not a significant risk factor in the ruptured group, but a continuously higher risk for women for intact AAA repair was found (OR 1.5, $P =$ .01). Other risk factors influenced the risk more, including renal impairment (OR, 2.4; $P < .001$) and heart disease (OR, 1.7; $P < .001$). This could reflect selection in the study population and the use of several risk factors in the analysis, which probably influences the results in the SWEDVASC and the NIS report.

Men more commonly have an aneurysm neck, iliac arteries, and tortuosity that allow EVAR. This results in an obvious sex difference in the EVAR/open repair ratio and could contribute to different outcome rates in a society with a high frequency of EVAR. Less than 11% of all elective repairs were EVAR in this material, and our findings cannot be extrapolated to societies with a higher rate of EVAR. As in most reports, our data showed that patients treated with EVAR for nonruptured AAA had an improved outcome at 30 days, but not after 1 year.[35-37]

The high mortality rate ≤30 days after surgery for ruptured AAA must still be compared to the >99% mortality rate in untreated patients. In their report, Patel et al[38] concluded that surgical repair of ruptured AAA is cost-effective. The overall 30-day mortality risk has, however, decreased during the last years, and improvement can also be shown in the analysis for 31 days to 1 year. The continuous increased risk of death ≤6 months after intervention for patients treated for ruptured AAA compared with the population should be emphasized; this is maybe best illustrated by comparison with the age-matched population.

A previous study from our group found that women had a higher risk for aneurysm-related death than men after successful repair of AAA.[32] Therefore, the causes of death ≤1 year were analyzed in detail in this report. Other cardiovascular diseases dominated, however, which indicates that the increased risk for women to die from aneurysm-related causes is most pronounced 1 year after surgery.

Our data are based on all patients treated in Sweden, with a high validity regarding type of intervention, number of interventions, time of procedure, and date of death. All major vascular procedures are performed in community-based hospitals and are registered with the NBHW because of the reimbursement system. The limitations of register-based studies are well known, such as a limited number of possible variables to analyze. Missing cases would be a small problem because health providers must report treated patients to receive funding. Furthermore, all data extracted from the NBHW are possible to analyze on a patient-specific level, which increases the strength of the analyses performed.

CONCLUSIONS

Interventions for nonruptured AAA— but not for ruptured AAA—increased over time, with an expected rapid increase of EVAR in the nonruptured group. The unchanged fraction of female patients over time possibly reflects the true distribution of AAA between the sexes. The postoperative survival after treatment of AAA improved, as anticipated, over time. The survival data for women and men treated in Sweden highlight that preoperative risk evaluation regarding postoperative survival not should include female sex as a risk factor, but rather older age or open repair.

AUTHOR CONTRIBUTIONS

Conception and design: EL, JS, RH
Analysis and interpretation: EL, FG, RH
Data collection: EL, FG
Writing the article: EL, RH
Critical revision of the article: EL, FG, JS, RH
Final approval of the article: EL, FG, JS, RH
Statistical analysis: EL, FG
Obtained funding: JS, RH
Overall responsibility: RH

REFERENCES

1. Bengtsson H, Bergqvist D, Sternby NH. Increasing prevalence of abdominal aortic aneurysms. A necropsy study. Eur J Surg 1992;158: 19-23.
2. Acosta S, Ogren M, Bengtsson H, Bergqvist D, Lindblad B, Zdanowski Z. Increasing incidence of ruptured abdominal aortic aneurysm: a population-based study. J Vasc Surg 2006;44:237-43.
3. Best VA, Price JF, Fowkes FG. Persistent increase in the incidence of abdominal aortic aneurysm in Scotland, 1981-2000. Br J Surg 2003; 90:1510-5.
4. Filipovic M, Goldacre MJ, Roberts SE, Yeates D, Duncan ME, Cook-Mozaffari P. Trends in mortality and hospital admission rates for abdominal aortic aneurysm in England and Wales, 1979-1999. Br J Surg 2005;92:968-75.
5. Olsson C, Thelin S, Stahle E, Ekbom A, Granath F. Thoracic aortic aneurysm and dissection: increasing prevalence and improved outcomes reported in a nationwide population-based study of more than 14,000 cases from 1987 to 2002. Circulation 2006;114:2611-8.
6. Hultgren R, Olofsson P, Wahlberg E. Gender differences in vascular interventions for lower limb ischaemia. Eur J Vasc Endovasc Surg 2001;21:22-7.
7. Pleumeekers HJ, Hoes AW, van der Does E, van Urk H, Hofman A, de Jong PT, Grobbee DE. Aneurysms of the abdominal aorta in older adults. The Rotterdam Study. Am J Epidemiol 1995;142:1291-9.
8. Scott RA, Bridgewater SG, Ashton HA. Randomized clinical trial of screening for abdominal aortic aneurysm in women. Br J Surg 2002;89: 283-5.
9. Dueck AD, Johnston KW, Alter D, Laupacis A, Kucey DS. Predictors of repair and effect of gender on treatment of ruptured abdominal aortic aneurysm. J Vasc Surg 2004;39:784-7.
10. Dillavou ED, Muluk SC, Makaroun MS. A decade of change in abdominal aortic aneurysm repair in the United States: have we improved outcomes equally between men and women? J Vasc Surg 2006;43: 230-8; discussion 238.
11. Semmens JB, Norman PE, Lawrence-Brown MM, Holman CD. Influence of gender on outcome from ruptured abdominal aortic aneurysm. Br J Surg 2000;87:191-4.
12. Menard MT, Chew DK, Chan RK, Conte MS, Donaldson MC, Mannick JA, et al. Outcome in patients at high risk after open surgical repair of abdominal aortic aneurysm. J Vasc Surg 2003;37:285-92.

13. Akkersdijk GJ, Prinssen M, Blankensteijn JD. The impact of endovascular treatment on in-hospital mortality following non-ruptured AAA repair over a decade: a population based study of 16,446 patients. Eur J Vasc Endovasc Surg 2004;28:41-6.
14. Brown LC, Powell JT. Risk factors for aneurysm rupture in patients kept under ultrasound surveillance. UK Small Aneurysm Trial Participants. Ann Surg 1999;230:289-96; discussion 296-7.
15. Solberg S, Singh K, Wilsgaard T, Jacobsen BK. Increased growth rate of abdominal aortic aneurysms in women. The Tromso study. Eur J Vasc Endovasc Surg 2005;29:145-9.
16. Schouten O, van Laanen JH, Boersma E, Vidakovic R, Feringa HH, Dunkelgrun M, et al. Statins are associated with a reduced infrarenal abdominal aortic aneurysm growth. Eur J Vasc Endovasc Surg 2006; 32:21-6.
17. Mofidi R, Goldie VJ, Kelman J, Dawson AR, Murie JA, Chalmers RT. Influence of sex on expansion rate of abdominal aortic aneurysms. Br J Surg 2007;94:310-4.
18. Lanne T, Sandgren T, Sonesson B. A dynamic view on the diameter of abdominal aortic aneurysms. Eur J Vasc Endovasc Surg 1998;15: 308-12.
19. Visser P, Akkersdijk GJ, Blankensteijn JD. In-hospital operative mortality of ruptured abdominal aortic aneurysm: a population-based analysis of 5593 patients in The Netherlands over a 10-year period. Eur J Vasc Endovasc Surg 2005;30:359-64.
20. McPhee JT, Hill JS, Eslami MH. The impact of gender on presentation, therapy, and mortality of abdominal aortic aneurysm in the United States, 2001-2004. J Vasc Surg 2007;45:891-9.
21. Norman PE, Semmens JB, Lawrence-Brown MM, Holman CD. Long term relative survival after surgery for abdominal aortic aneurysm in western Australia: population based study. BMJ 1998;317:852-6.
22. Reitsma JB, Pleumeekers HJ, Hoes AW, Kleijnen J, de Groot RM, Jacobs MJ, et al. Increasing incidence of aneurysms of the abdominal aorta in The Netherlands. Eur J Vasc Endovasc Surg 1996;12:446-51.
23. European Society for Vascular Surgery. First Vascunet database report. The European Society for Vascular Surgery; September 2007. Available at: http://www.esvs.org/?vis=57.
24. Kantonen I, Lepantalo M, Brommels M, Luther M, Salenius JP, Ylonen K. Mortality in ruptured abdominal aortic aneurysms. The Finnvasc Study Group. Eur J Vasc Endovasc Surg 1999;17:208-12.
25. Dueck AD, Kucey DS, Johnston KW, Alter D, Laupacis A. Long-term survival and temporal trends in patient and surgeon factors after elective and ruptured abdominal aortic aneurysm surgery. J Vasc Surg 2004;39: 1261-67.
26. Causes of Death 2005, "Hälsa och Sjukdomar" Centre for Epidemiology of the National Board of Health and Welfare; 2007:15.
27. Singh K, Bonaa KH, Jacobsen BK, Bjork L, Solberg S. Prevalence of and risk factors for abdominal aortic aneurysms in a population-based study: the Tromso Study. Am J Epidemiol 2001;154:236-44.
28. Evans SM, Adam DJ, Bradbury AW. The influence of gender on outcome after ruptured abdominal aortic aneurysm. J Vasc Surg 2000; 32:258-62.
29. Kantonen I, Lepantalo M, Salenius JP, Matzke S, Luther M, Ylonen K. Mortality in abdominal aortic aneurysm surgery–the effect of hospital volume, patient mix and surgeon's case load. Eur J Vasc Endovasc Surg 1997;14:375-9.
30. Holt PJ, Poloniecki JD, Gerrard D, Loftus IM, Thompson MM. Meta-analysis and systematic review of the relationship between volume and outcome in abdominal aortic aneurysm surgery. Br J Surg 2007; 94:395-403.
31. Eckstein HH, Bruckner T, Heider P, Wolf O, Hanke M, Niedermeier HP, Noppeney T, Umscheid T, Wenk H. The relationship between volume and outcome following elective open repair of abdominal aortic aneurysms (AAA) in 131 German hospitals. Eur J Vasc Endovasc Surg 2007;34:260-6.
32. Hultgren R, Granath F, Swedenborg J. Different disease profiles for women and men with abdominal aortic aneurysms. Eur J Vasc Endovasc Surg 2007;33:556-60.
33. Johnston KW. Influence of sex on the results of abdominal aortic aneurysm repair. Canadian Society for Vascular Surgery Aneurysm Study Group. J Vasc Surg 1994;20:914-923; discussion 923-6.
34. Wanhainen A, Bylund N, Bjorck M. Outcome after abdominal aortic aneurysm repair in Sweden 1994-2005. Br J Surg 2008;95:564-70.
35. Greenhalgh RM, Brown LC, Kwong GP, Powell JT, Thompson SG. Comparison of endovascular aneurysm repair with open repair in patients with abdominal aortic aneurysm (EVAR trial 1), 30-day operative mortality results: randomised controlled trial. Lancet 2004;364:843-8.
36. Prinssen M, Verhoeven EL, Buth J, Cuypers PW, van Sambeek MR, Balm R, Buskens E, Grobbee DE, Blankensteijn JD. A randomized trial comparing conventional and endovascular repair of abdominal aortic aneurysms. N Engl J Med 2004;351:1607-8.
37. Blankensteijn JD, de Jong SE, Prinssen M, van der Ham AC, Buth J, van Sterkenburg SM, Verhagen HJ, Buskens E, Grobbee DE. Two-year outcomes after conventional or endovascular repair of abdominal aortic aneurysms. N Engl J Med 2005;352:2398-405.
38. Patel ST, Korn P, Haser PB, Bush HL, Jr., Kent KC. The cost-effectiveness of repairing ruptured abdominal aortic aneurysms. J Vasc Surg 2000;32:247-57.

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